Eng Int Syst (2024) 5: 421–433

Engineering
Intelligent Systems

Big Data Theory of Industrial Supply Chain Based on Complex Information Integration

Weihuang Dai[1], Zijiang Zhu[1,2,3], and Deyu Qi[2,3]*

[1] *Research Center for Collaboration Innovation of Airport Economy (RCCIAE), South China Business College of Guangdong University of Foreign Studies, Guangzhou 510545, Guangdong, China*
[2] *Institute of Digitization Science and Technology, South China Business College of Guangdong University of Foreign Studies, Guangzhou 510545, Guangdong, China*
[3] *School of Computer Science, South China Business College of Guangdong University of Foreign Studies, Guangzhou 510545, Guangdong, China*

The development of big data provides a more adequate foundation for the management and construction of traditional industrial supply chain finance. This article discusses the research on big data theory in industrial supply chains based on complex information integration. This paper proposes and designs a big data system for the common industry supply chain. The whole system architecture is comprised of: platform support layer, data resource layer, data processing layer, internal business layer and public service layer. The platform support layer provides public services for financial big data, and addresses all problems related to infrastructure, hardware resources, and software environment. The data resource layer is used for the management of the list of rights and responsibilities and the list of events. The data processing layer can transform the information into understandable knowledge. The internal business layer is logically isolated from the Internet to ensure information security. The operation module of the supply chain industry standardizes the interface between logistics, the supply chain management system and related collaborative supervision system. Based on this, the research on complex information integration of industrial supply chain is carried out to improve the parallel processing efficiency of big data. Through complex information integration, the parallel processing efficiency of big data in industrial supply chain has increased by 76%, the execution time is short, and the alignment performance is better. The results show that the system designed in this paper can reasonably develop the data resources in the online supply chain and improve the parallel processing efficiency of big data in the industrial supply chain.

Keywords: Big Data, Complex Information Integration, Industrial Supply Chain, Complex System Theory

1. INTRODUCTION

With the development of industrial modernization technology, the theoretical research of big data in the industrial supply chain of information integration becomes more and more important. Regarding the collaborative development model of the supply chain industry big data system, various division methods have appeared according to different standards. The supply chain big data system is a complex whole with multiple components cooperating with each other. Each component can make the system run stably only if each component performs its duties and functions sufficiently. To promote the orderly operation of each component requires another organization within the system, a financial services big data center, to make constructive and adequate coordination.

Formalizing the description of the corpus, as it uses fundamental elements in modern technology and meets the requirements of MOS, makes the understanding of big data more unified. Mauro identifies and describes the most significant research areas related to 'big data' and provides

*Address for correspondence: Deyu Qi, Institute of Digitization Science and Technology, South China Business College of Guangdong University of Foreign Studies, Guangzhou 510545, Guangdong, China and School of Computer Science, South China Business College of Guangdong University of Foreign Studies, Guangzhou 510545, Guangdong, China, Email: qdygwng@163.com

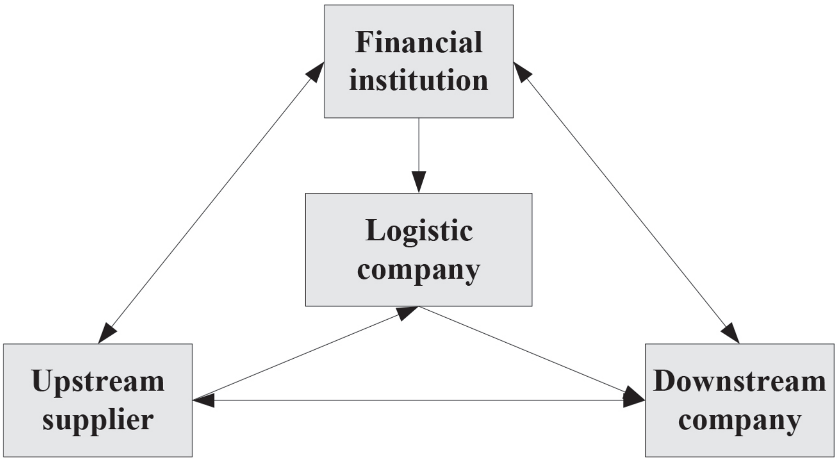

Figure 1 Prepaid account financing model.

a comprehensive definition of this term. He conducted extensive analysis on a large number of industries and academic papers related to big data, hoping to identify some common topics. At the same time, he also studied various existing definitions to come up with a more reliable definition that covers most of the work in this field. His research lacks data [1]. Xu takes a broader perspective on privacy issues related to data mining and explores various ways to protect these privacy rights. His experiment is so simple [2]. Firstly, Cai provides a functional framework for collecting, managing, processing, and mining big data on the Internet of Things. On this basis, the current research status of IoT applications was analyzed, and the challenges and opportunities faced by IoT big data research were pointed out. On this basis, this project will also analyze several unresolved issues and application examples in the Internet of Things. His research methods are not novel enough [3]. Chi believes that countries around the world have numerous ground stations and aviation sensors, providing us with a vast amount of remote sensing data. He particularly pointed out that big data provides new opportunities and challenges for the development of remote sensing technology. We will focus on studying the connotation of remote sensing big data and its value-added role in this context. In addition, he also proposed the challenge of effectively managing, processing, and using big data to process remote sensing data. To clarify the above issues, he discussed through two examples of applying big data. His research lacks data [4].

The platform support layer addresses all problems related to infrastructure, hardware resources, and software environment for financial big data public services. The data resource layer is used for the management of the rights and responsibilities list and item catalog, and the data processing layer can transform information into understandable knowledge. The internal business layer is based on the e-finance cloud platform and the e-finance extranet deployment, and is logically isolated from the Internet to ensure information security. The financial service big data center requires various functional departments to open the data of relevant fields and industries through the data open platform in the form of data sets through the work deployment method, which is conducive to promoting the social development and utilization of financial big data. The operation module of supply chain finance standardizes the interface between logistics and supply chain management systems and related collaborative supervision systems.

2. INDUSTRIAL SUPPLY CHAIN BIG DATA SYSTEM BASED ON COMPLEX INFORMATION INTEGRATION

2.1 Industrial Supply Chain Big Data System

In the supply chain process, there may be funding gaps at different stages, allowing for various forms of financing [5–6]. In the procurement stage, a financing model based on prepaid accounts can be used [7]. In the production stage of the enterprise, a financing model based on inventory pledge can be used; in the sales stage, because the downstream company defaults on the payment in the form of accounts receivable at the time of settlement, which affects the normal capital flow of the company, financing needs can be used based on accounts receivable The financing model [8–9].

(1) Prepayment financing model

The prepayment financing model is shown in Figure 1 [10]. The typical representative of the prepaid account financing model is the confirmation warehouse. The confirmation warehouse model is suitable for small and medium-sized enterprises in the procurement process of financing needs [11–12].

(2) Inventory pledge financing model

In the off-season, when companies produce a large number of products backlogged in warehouses, companies can adopt the financing model of inventory pledge [13]. Hence, this greatly reduces the bank's operational process [14–15]. Due to the small number of activities that banks undertake in this business mode, this research focuses on the specific operation process of the principal-agent model [16].

(3) Accounts receivable financing model

In the financing of accounts receivable, third-party logistics companies can also be appropriately introduced as third-party guarantors according to actual needs [17–18].

2.2 Complex System Organization Mechanism of Financial Resource Allocation

According to the general law of potential energy definition, in the financial resource system, whether in space or time, the driving force driving the movement of financial resources should be consistent with the gradient direction of the potential energy of financial resources [19]. Therefore, the potential energy of financial resources can be expressed as:

$$dH = f(dv, dp, dM) \tag{1}$$

Among them, dH is the change of financial resource potential energy, and dM is the change of financial resource value potential energy [20]. According to system resource optimization configuration requirements, let:

$$p(t) = \sum_{i=1}^{n} p_i F_i \tag{2}$$

$$p_i = e^{-rt}\left[a_1 p_s + a_2 p_E + a_3 p_0\right] \tag{3}$$

Among them, p_i is the value of financial asset F, then:

$$\frac{F}{F_i} = \lambda_i + \sum_{m=t}^{M} \alpha_n \frac{X}{X_m} \tag{4}$$

2.3 Resource Optimization Model of Complex Industrial Supply Chain Resource System

This requires the use of chaos control principles and dynamic optimization methods to establish a resource optimization control model for complex industrial supply chain resource systems, and to determine the "chaotic solution" of system evolution. The traditional resource theory believes that due to the "law of diminishing marginal returns" in the use of resources, the use of resources has reached the "Pareto optimal". However, this is only a short-term "equilibrium" due to the systematic production technology and the greater certainty of the system's short-term production behavior. In the long-term process of the financial resource system, the development of the system will be "unbalanced", and the marginal return may be "decreasing", "increasing" and unchanged. Obviously, only the nonlinear dynamics model of complex financial resource system resources can explain the long-term behavior of system development [21–22].

(1) Establishment of the optimal combination model of production unit resources

Suppose that N types of financial production resources R are invested in M production units for production, and the generalized C-D production function of financial resources:

$$F_i(X) = e^{\lambda} \prod_{n=1}^{N} X_n^{a_n} \tag{5}$$

Among them, F is the product quantity of the production unit (industry) at time i at t. Solow residual value growth equation can be obtained:

$$\frac{F}{F_i} = \lambda_i + \sum_{n=1}^{N} a_n \frac{X}{X_i} \tag{6}$$

Among them,

$$F_t = F_{i,t+1} - F_{i,t} \tag{7}$$

$$X_i = X_{t+1} \tag{8}$$

Determine the parameter a by regression identification or DEA method, and set the macroscopic effect function of the q-level system:

$$H_q(X,t) = \int_0^T e^{-rt}\left[a_1 p_E + a_2 p_E + a_3 p_0\right] F dt \tag{9}$$

Among them, r is the bank interest rate, which mainly considers the time value of resource allocation. T for the resource optimization period. The optimal utilization of the resource combination in the system requires that the marginal production returns of purchasing input elements at unit prices in the production unit be equal in the short term, then:

$$X = \left[\frac{F_i}{e^{\lambda,t}\prod_{n=1}^{N}\frac{P}{P_i\alpha}}\right]^{\frac{1}{\sum_{m}^{m=1} a}} \tag{10}$$

$$X_i = \frac{X_i \alpha_1 p_i}{P_1 a_i}\, n = 1, 2, \ldots, N \tag{11}$$

$$\frac{X}{X_i} = \frac{1}{\sum_{n=1}^{N} a_n}\left(\frac{F}{F_i} + a_1 \sum_{n=1}^{N}\frac{P}{P_i} - N\frac{P_t}{p} - \lambda\right) \tag{12}$$

It shows that the optimal allocation of resources is related to the price of input factors and the demand of the real economy. Defined by the resource structure:

$$\frac{X}{X_i} = \frac{X_1}{X_m} + \frac{S}{S_m} \tag{13}$$

S is the resource allocation structure, which can be determined by the dynamic model of the optimal allocation of resources among production units.

$$\frac{x}{x_n} = \frac{1}{\sum_{n=1}^{1} a_n}\left(\frac{X}{X_m}\sum_{n=1}^{N} a + \sum_{n=1}^{N}\frac{S_i}{S} + a\sum_{n=1}^{N}\frac{P}{P_i} + N\frac{P}{P_1}\right) \tag{14}$$

(2) Dynamic model of optimal allocation of resources among production units

Suppose $A_i(t)$ is the production resources of t in the production unit of i at time, then:

$$\Delta A = W_t + \Delta N_t + D_t = W_t + \frac{A_1}{A}\Delta A + D_t \tag{15}$$

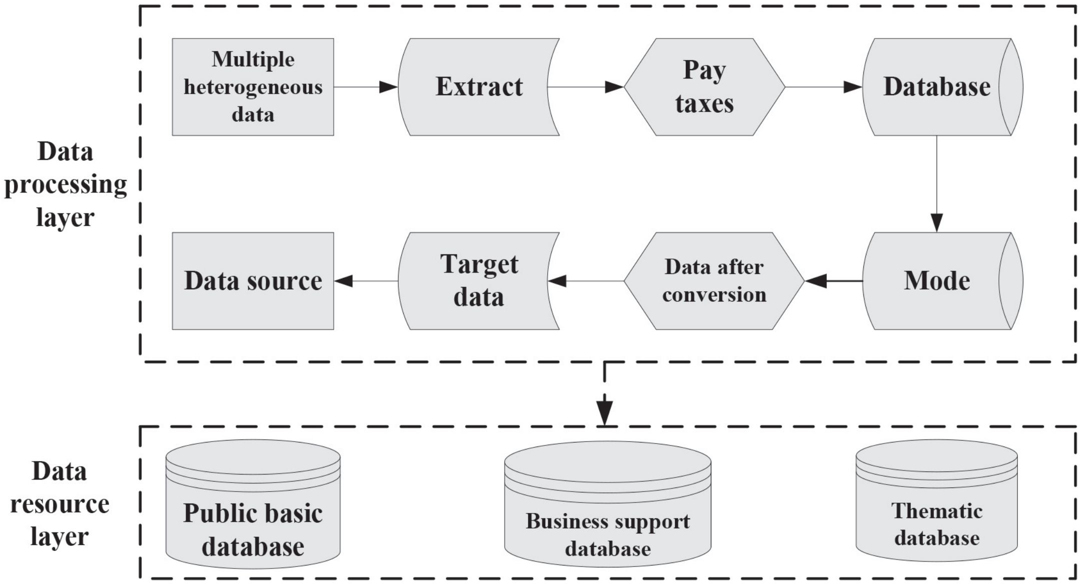

Figure 2 The overall architecture of the supply chain big data system.

The ability of resource flow W_t within t is related to the current scale of financial development and the production structure of the entire system, as follows:

$$\Delta A = \Delta A_f \times f_t(X, V, P) \times \Delta t + \frac{A_t}{A}\Delta A \qquad (16)$$

Consider the linear expression of $f_t(X, V, P)$:

$$f_T(X, V, P) = \sum_{j=1}^{n} a_{ij} x_j \qquad (17)$$

$$x_i = x_j \sum_{j=1}^{n} a_{ij} x_j \qquad (18)$$

Among them, x_i is a resource nonlinear dynamics model of a complex financial resource system, as well as a resource system configuration model.

3. DESIGN EXPERIMENT OF INDUSTRIAL SUPPLY CHAIN BIG DATA THEORY SYSTEM BASED ON COMPLEX INFORMATION INTEGRATION

3.1 Overall Architecture of the Supply Chain Big Data System

The function of the supply chain big data system is to ensure the orderly development of the financial big data system and to promote the concentration, analysis, development, application, opening, and trading of various data resources in financial activities. The structure of the big data platform for supply chain finance is complex, involving various subsystems (components) such as infrastructure, cloud computing resources, software systems, experts, functional departments, databases, and relevant standards, regulations, agreements, safeguards, and regulations. Regarding the relationship between the work of each component, the entire architecture can be divided into five levels, from the bottom to the item level: platform support layer, data resource layer, data processing layer, internal business layer, and public service layer. The overall architecture of the supply chain big data system is shown in Figure 2.

(1) Platform support layer. That is, the electronic financial public service platform based on cloud computing solves all the problems about infrastructure, hardware resources, software environment and other issues for financial big data public services. It is the foundation of financial big data development and works at the bottom.

(2) Data resource layer. The business support database is mainly used to support online work, administrative approval, etc., to promote the efficient and quick, convenient and beneficial of public services. It mainly includes electronic certificate database, financial service item catalog and process database, and processing data database to realize the reuse of declared data, Historical record database, power and responsibility list and item catalog management used to mine data value, as well as policy and regulation database; the special database is the special database of the industry by each functional department to promote industry data mining and decision support. Among them, the public basic database and business support database are mainly structured data, and the thematic database is mainly unstructured and semi-structured data.

(3) Data processing layer. The function of the data processing layer is a link between the previous and the next, and the flow of data is realized in this layer. The analysis and processing of financial big data is mainly reflected in two aspects: one is to perform ETL (Extract-Transform-Load) processing on the data during the data collection process, which mainly includes the extraction, cleaning, filtering, conversion, and conversion of multiple and heterogeneous data sources. Through association, loading and other operations, the construction of the data warehouse is realized. The second is the database knowledge discovery process in the process of data mining, which mainly includes

the integration, selection, preprocessing, conversion, mining, expression and interpretation of a large number of data sources, so as to transform information into understandable knowledge. The data processing layer needs to use big data tools and methods to interact with various departments' business systems and various databases.

(4) Internal business layer. The main work in this layer is the business application systems built by various functional departments. These systems are used by the party and government agencies for collaborative office use. They are based on the electronic financial cloud platform and electronic financial extranet deployment, and are logically isolated from the Internet to ensure information security.

(5) Public service layer. The business application system working on the public service layer provides services and inquiry services for the masses or enterprises, and is open to the outside world through the Internet. At the same time, due to the high value density of financial data, in order to guide social forces to participate in the mining and analysis of financial data resources and promote the development of the big data industry, it is necessary to establish an open data platform. The financial service big data center requires various functional departments to open the data of relevant fields and industries through the data open platform in the form of data sets through the work deployment method, which is conducive to promoting the social development and utilization of financial big data.

(6) Big data service support system. To enable the supply chain big data system to operate smoothly and orderly, its supporting service system plays an important role and is indispensable. One is a unified and standardized application software technical standard and data format standard. Facilitate the use of data on demand and co-construction and sharing. The second is the unified data exchange sharing contract and data usage rules that are followed. Ensure that the data is not leaked or used for unauthorized purposes. The third is the unified deployment of network information security strategies and security measures. Management data leakage and illegal use need to establish a mechanism to make up for it. The fourth is the uniformly formulated rules and regulations, management methods and guarantee mechanisms.

3.2 Supply Chain Operation Support Module

The supply chain operation technical support module is composed of four levels: the collaborative supervision layer, the supply chain entity industry layer, the supply chain service layer, and the basic payment layer. These four hierarchical structures are both interrelated and independent. The guarantee for the docking between various information systems is information exchange and information sharing, and the basis and foundation of system docking are the standard of interface messages. The standardization of the interface has to solve two key problems: the first is the standardization of the interface between the modern payment system of the People's Bank of China and the fund clearing system of various commercial banks; the second is the commercial bank supply chain financial service system and enterprise ERP system, e-commerce Standardization of the interface between transaction systems, logistics and supply chain management systems and related collaborative supervision systems.

(1) Coordinating supervision layer

The role of the coordinated supervisory layer is to regulate the order of the financial market, improve the efficiency of government management, and facilitate the implementation of coordinated supervision by external supervisors. It focuses on financial supervision, tax supervision and quality supervision. It is conducive to the division of responsibilities and functions and interests of financial and government supervision departments.

(2) The physical industry layer of the supply chain

This layer is the main participating layer of online supply chain finance. It is mainly composed of entity enterprises, including core enterprises, upstream and downstream enterprises, logistics and supply chain management enterprises and e-commerce transaction centers. They connect their respective application systems to the online supply chain service system, which can meet the information needs of all participating entities, and can integrate the company's ERP system, e-commerce transaction platform system, logistics and supply chain management system and other transaction payment information streams are aggregated and integrated to form an orderly information sharing.

(3) Supply chain service layer

This layer is the provider of supply chain services and online payment services, mainly commercial banks, but also third-party independent institutions. This layer structure is mainly composed of commercial bank online banking payment gateway, supply chain service system and commercial bank payment clearing system.

(4) Basic payment layer

The basic payment layer includes domestic clearing institutions of the People's Bank of China and international payment clearing organizations. The payment service system provided by the PBC's clearing agency is China's modern payment system. The International Payment and Settlement Organization provides CHIPS, SWIFT and other clearing systems. The basic payment layer is the guarantee for the smooth realization of the financial payment function of the online supply chain. The main function is to standardize and link domestic and foreign payment systems.

3.3 Operational Organization Structure of The Industrial Supply Chain

The operating structure of supply chain finance consists of four platforms, external regulators and five major participants. The platform is an online supply chain financial transaction platform and a logistics and supply chain management platform. External regulators include industrial and commercial enterprises and government agencies. Participants include commercial banks and core enterprises, which not only provide a platform for multi-party collaboration for each participant, but also provide more effective supervision channels for external supervisors.

3.4 System Function Requirement Design

(1) Risk data loading layer

At the risk data loading layer, the supply chain participants will send relevant information to the system in batches in an external flat table format separated by vertical lines (such as the credit rating table of commercial banks, the stock collateral of logistics enterprises, and the prepayment warehouse of the core enterprise Warehouse Receipts Single table, SME Debtors accounts receivable table, etc.), which is imported by the system through the flat table. The import method uses the oracle external flat table import tool SQL*Loader. SQL* Loader is a tool for Oracle database to import external data. It is similar to the Load tool of DB2, but there are more choices and options. It supports changing loading modes, which includes optional loading and multi-table loading. There are two prerequisites for using SQL*Loader to clean and load the source table. The information needs to be distributed in an external flat table format separated by a vertical line.

(2) Risk information modeling

According to the basic data provided by the risk data loading layer, select the appropriate risk model in the risk model library, carry out data conversion and processing for the dimensions and topics of the risk model, and finally convert the complex redundant data of the native supply chain into a risk analysis Information. The “Inventory Financing Risk Analysis Dimension” model needs to assess the ownership of the goods, the supply and demand of the goods, and the industry risks of the goods. These data are provided by different participants in the supply chain and collected through their own source tables. Obtain the ownership of the goods and the identification of the quality of the goods through the Stock table of collaterals, and obtain the price fluctuations and industry risk status of the goods in the industry through the Industry Information Table. Through the associated foreign key of each source table to perform association and subject dimension processing, and finally obtain the inventory financing risk analysis dimension table for risk decision-making.

3.5 Database Design

The design of the database is the core part of the system, and the rationality of the database table structure plays a vital role in the long-term stable operation of the later system. The core table of the database mainly includes the information of various roles in the supply chain, including the commercial bank table, the logistics enterprise table, the core enterprise table, and the small and medium-sized enterprise table: corporate credit information includes enterprise reputation table, loan record table, and repayment record table; market macro information includes market table, commodity type table; three modes of supply chain financing pledge information including inventory collateral table, accounts receivable table, prepaid billing statement table; risk control information includes risk record table, risk model table. Among them, the supply chain role information table and the corporate credit information table have a one-to-many relationship, the supply chain role information table and the supply chain financing three modes pledge information table have a one-to-many relationship, the market macro information table and the supply chain individual tables in the pledge information of each role information/supply chain financing three modes constitute a one-to-many relationship, and the risk control information table and the three supply chain financing pledge information tables constitute a one-to-many relationship.

According to the different nature of the industry, the industry is divided into several types, and each industry has its specific name and type. More importantly, according to the nature of different industries, the industry stability factor score and industry risk factor score are entered according to the current market conditions, and updated in time according to changes in the industry market. The industry information table forms a one-to-many relationship with the supply chain role information tables that will be introduced later, and is associated with Industry_id as a foreign key. Each supply chain role belongs to a certain category in the industry information table, and the industry stability coefficient score and risk factor score will have a macro impact on the company’s risk assessment.

4. INDUSTRIAL SUPPLY CHAIN BIG DATA SYSTEM BASED ON COMPLEX INFORMATION INTEGRATION

4.1 Supply Chain Finance Big Data System

① It is understood that core enterprises A and W Bank have reached a cooperation agreement to provide internet supply chain financial services for the upstream and downstream of Company A’s supply chain. Company B is a supplier of a certain household appliance product on its online self operated e-commerce platform. Company A and Company B are both listed companies in Shanghai and Shenzhen. W Bank needs to assess the credit risk of the financing company As a domestic self operated e-commerce platform and a core enterprise with huge transaction data records from upstream and downstream enterprises, Company C has also reached a cooperation agreement with commercial bank Company W to provide supply chain financing for its suppliers and purchasers. Company D is engaged in the electrical industry. It is a long-term supplier of Company C. Company D requests financing from the bank, and Bank W needs to evaluate the credit risk of Company D. The financing risks of the first option are shown in Figure 3, while the financial risks of the second option are shown in Table 4. The example analysis

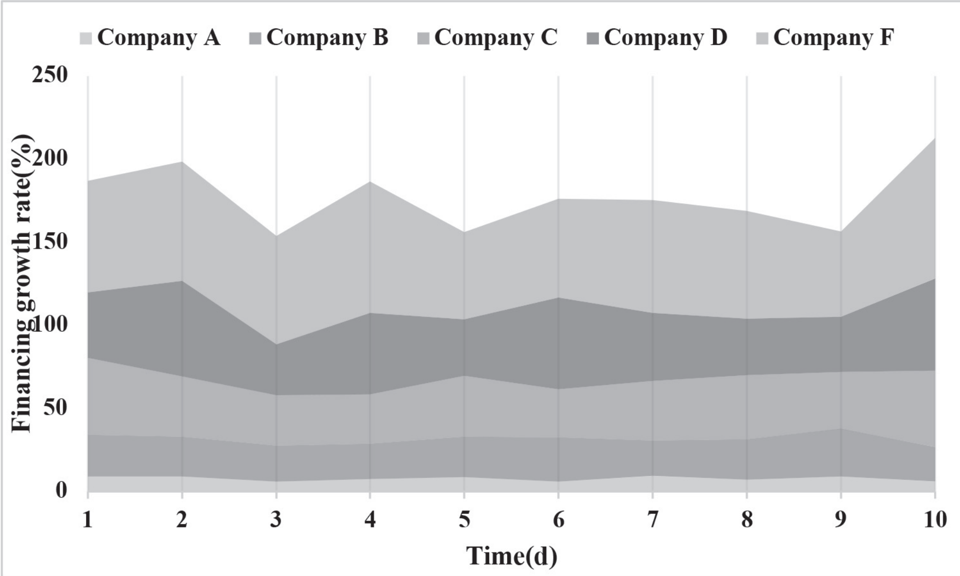

Figure 3 The financing risk rate of the first option.

Table 1 Example analysis results.

Alternative indicators	Financing company B	Financing Enterprise D	Financing Enterprise F
Manager quality (0.2)	0.2	0.2	0.2
Staff quality (0.1)	01	0.1	0.1
Corporate governance status (0.9)	0.6	0.9	0.6
Operational capacity (4)	3	4	3
Solvency (10)	9	10	6
Profitability (5)	5	5	5
Growth ability (1.3)	1.2	0.9	1.6
Credit status (8)	8	2	8

Table 2 Macro Annual Data.

China Macro Annual Data Sheet Group by Province			
Table Name	Table notes	Attributes	Attribute notes
tb_mecroyr_code	Index table	Code	Secondary indicator code (primary key)
		Procode	First-level indicator code (foreign key)
		Eunit	Index Chinese name
		Cmome	Index English name
		Cod	Unit Chinese name
		Cnane	District Chinese name
tb_mecroyr_code	Region table	Eneme	District English name
		Code	Year code (primary key)
		Code	Attribute notes

results are shown in Table 1. Based on the calculation of the above scoring structure, the financing risk scores of enterprises B, D, and F are 86.2, 90.3, and 71.2, respectively, with credit risk ratings of AA, AA, and A.

4.2 Different Pricing Strategies

In order to verify the above-mentioned related conclusions, discuss the impact of each entity's effort level on manufacturers, consumers and supply chain systems under different pricing strategies. Through simulation, discuss the effect of consumer effort coefficient a and manufacturer effort coefficient a on product price p, set parameters D=10000, θ=4000, c=80, and the analysis results of different pricing strategies are shown in Figure 5. The macro annual data is shown in Table 2. The relationship between consumer consumption coefficient and product price is shown in Figure 6. The relationship between the manufacturer's effort coefficient and product price is shown in Figure 7. Through simulation analysis, we observe the relationship between the sales price of products and the coefficient of consumer effort cost and the coefficient of manufacturer's innovation cost. When the coefficient of innovation effort cost increases, the

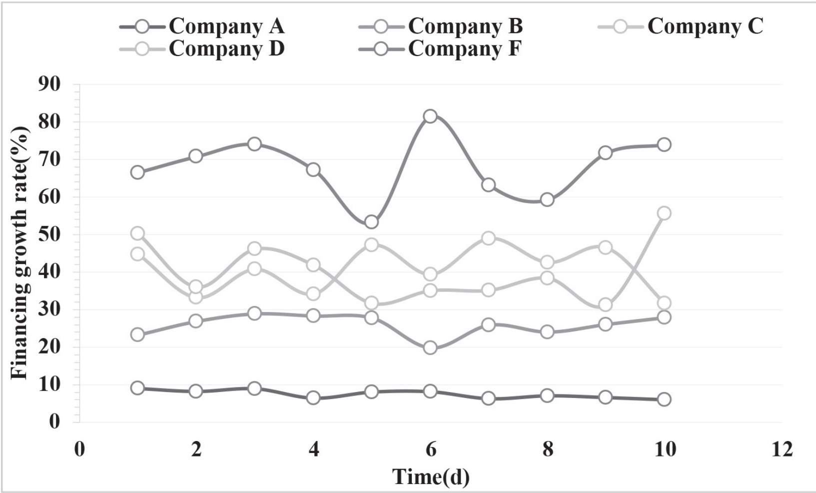

Figure 4 The financing risk rate of the second option.

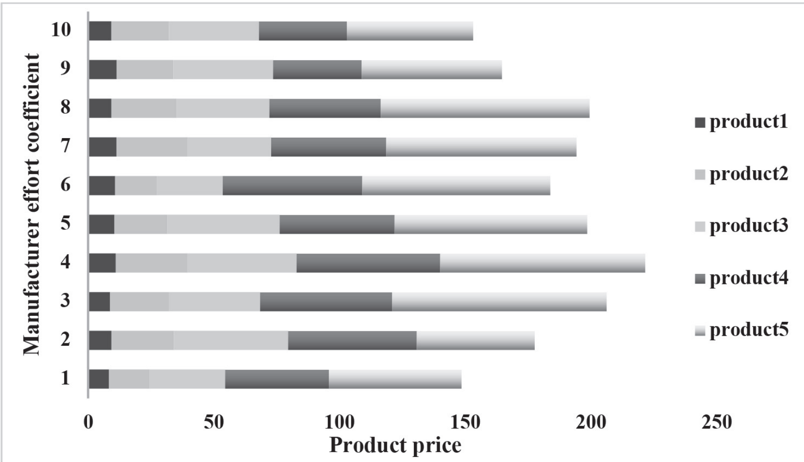

Figure 5 Analysis results of different pricing strategies.

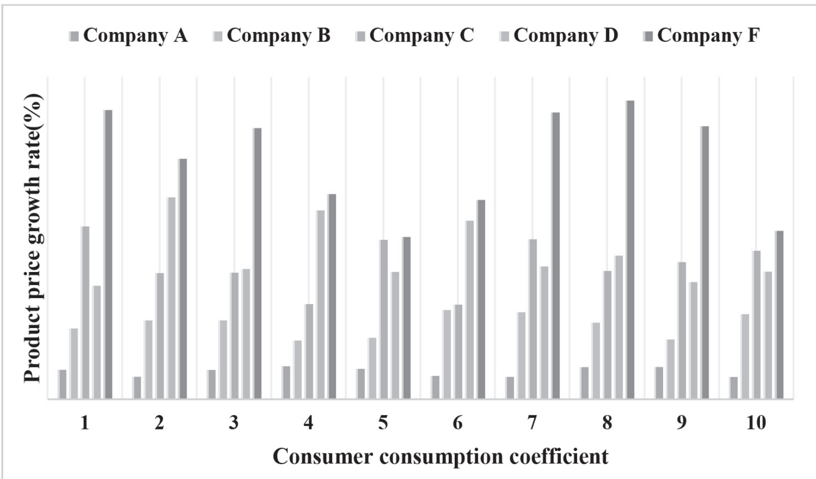

Figure 6 The relationship between consumer consumption coefficient and product price.

selling price of the product also increases, which shows that the selling price of the product is positively correlated with the effort cost coefficient of manufacturers and consumers. From the analysis of Figure 8, when the consumer's effort level is constant, the revenue of the manufacturer and the consumer is an increasing function. When the manufacturer's revenue reaches the threshold, due to the increase in effort cost, the manufacturer's and consumer's revenue will decrease. Because the cost of consumer effort is a quadratic function, as the cost of consumer effort increases, the benefits of

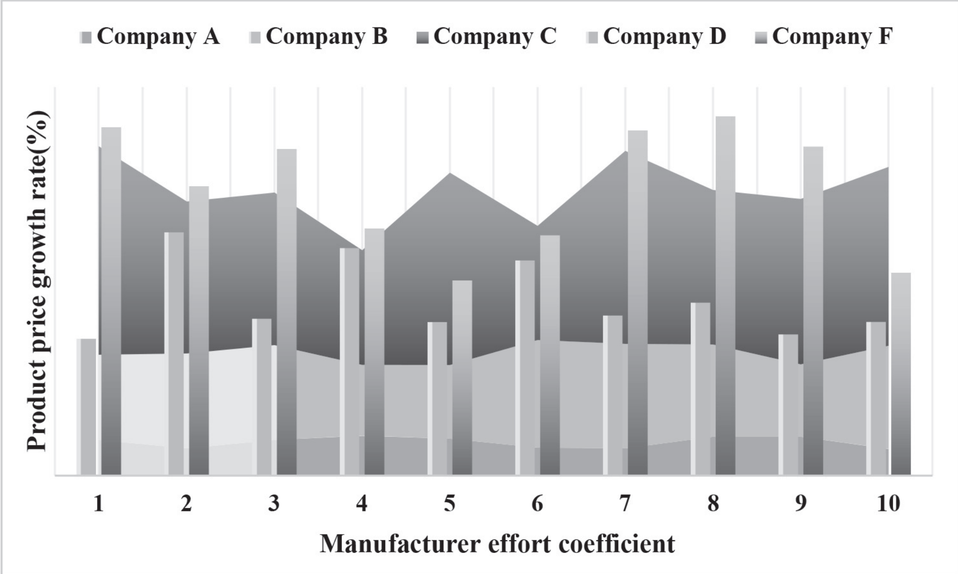

Figure 7 The relationship between manufacturer's effort coefficient and product price.

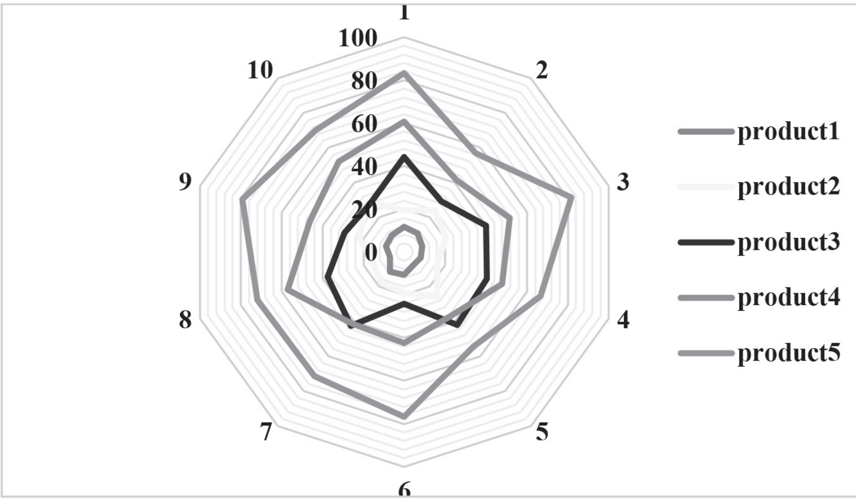

Figure 8 Risk analysis results of supply chain financing.

manufacturers and consumers increase within a certain range, but when the cost of effort exceeds the optimal effort level threshold, the cost of effort with the increase of, the profits of manufacturers and consumers will decrease.

4.3 Supply Chain Financing

The risk analysis results of supply chain financing are shown in Figure 8. It can be seen that the first-level risk index that has the greatest impact on the decision-making goal is the risk evaluation of financing projects, indicating that the risk evaluation of financing projects is the first to be considered in supply chain financing. Among the second-level indicators, except for the second-level indicators that belong to the risk evaluation of financing projects, debt solvency, profitability, credit status and Internet integration all have a greater impact on risk my country's annual financial data is shown in Table 3. In addition to traditional solvency, profitability, credit status and other factors that have a greater impact on the corporate risk assessment structure, the role of the Internet and related factors cannot be ignored, especially for Internet-related companies. Through the above analysis, it can be analyzed from a qualitative and quantitative perspective.

4.4 Supply Chain Financial Resources Allocation

The premise of using big data is to have real data sources. For online supply chain finance, these conditions can be met, so big data can be used to analyze the allocation of online supply chain financial resources. The allocation of supply chain financial resources is shown in Figure 10. ① The evaluation indicators of online supply chain financial resources have the characteristics of high dimensionality and high frequency. You can obtain capital changes on the online supply chain financial financing transaction platform, and obtain the real transaction status on the e-commerce platform,

Table 3 Country's annual financial data.

China Macro Annual National Data Sheet Group			
Table Name	Table notes	Attributes	Property notes
tb_macroy_code	Index table	Code	Secondary indicator code (primary key)
		Procode	First-level indicator code (foreign key)
		Cunit	Chinese name of indicator unit
tb_macroy_year	Data sheet	Eunit	English name of indicator unit
		Cname	Index Chinese name
tb_macroy_data	Table notes	Cmome	Chinese notes
		Emose	English remarks

Table 4 Industry Information.

Name	Code
Industry ID	Industry_ id
Industry Name	Industry_Name
Industry Type	Type
Industry stability factor score	Stable Score
Industry risk factor score	Risk Score

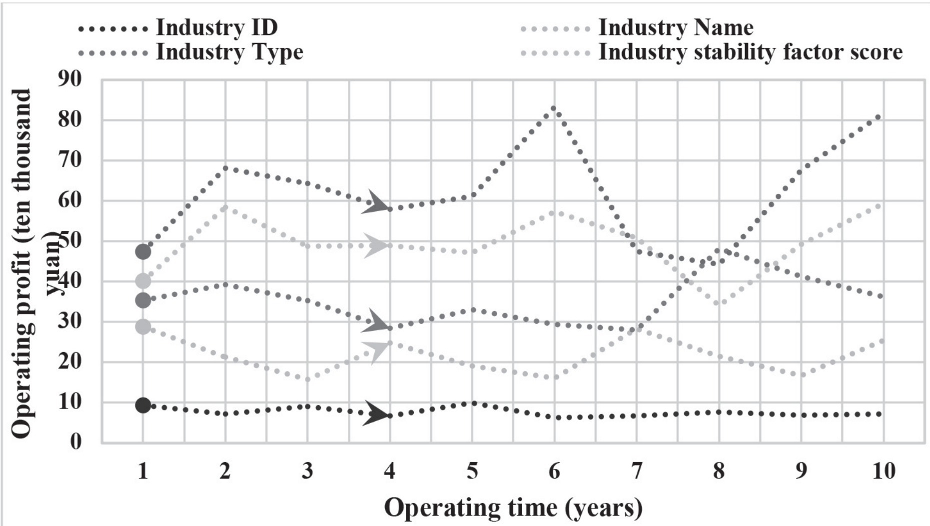

Figure 9 Industry specific information.

online payment platform, logistics and supply chain platform, big data can help us judge a series of changing laws. In this way, we can better determine the amount of financial resources invested in the online supply chain without causing a waste of financial resources. It can be used to evaluate the creditworthiness of target customers in online supply chain finance. Banks often determine whether to make loans by looking at corporate financial statements and transaction data, but these can be faked. The use of big data can conduct a comprehensive analysis of customers' financial data such as assets and liabilities, cash flow, production data such as order quantity, product cycle, inventory, and sales data, and conduct a more objective analysis, which will help reduce the risk of customer fraud. Making full use of big data to analyze the demand direction and demand of online supply chain finance and the credit evaluation of its target customers will help improve the efficiency of online supply chain financial resource allocation.

4.5 Investment Group Structure

The results of the impact analysis of the investment group structure are shown in Figure 11. Obviously, an investment group may request a transaction at every trading moment, but the frequency of its structural changes cannot be so fast. Therefore, an appropriate assumption is that the frequency of structural changes of the investment group is slower than the frequency of transactions. The model first realizes a dynamic evolution of the investment group structure, and then assumes that every time the virtual stock market evolves 50 steps, the investment group structure will change, that is, repeat the iteration of τ after 1 iteration 50 times. Therefore, with the evolution of the virtual stock market, all subjects are likely to enter the market to participate in transactions, so that the number of investors and the social network structure of the investment group will continue to change: clusters will grow slowly, and the herd effect will be gradually amplified;

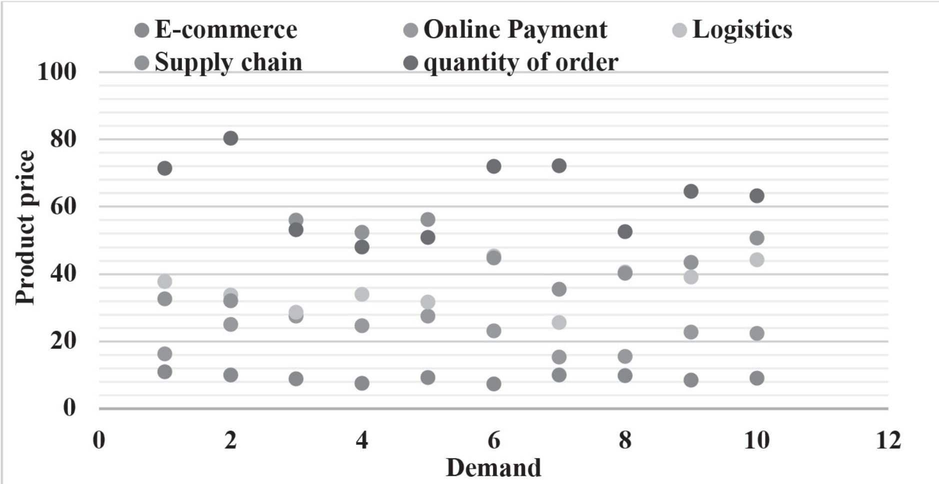

Figure 10 Supply chain financial resource allocation.

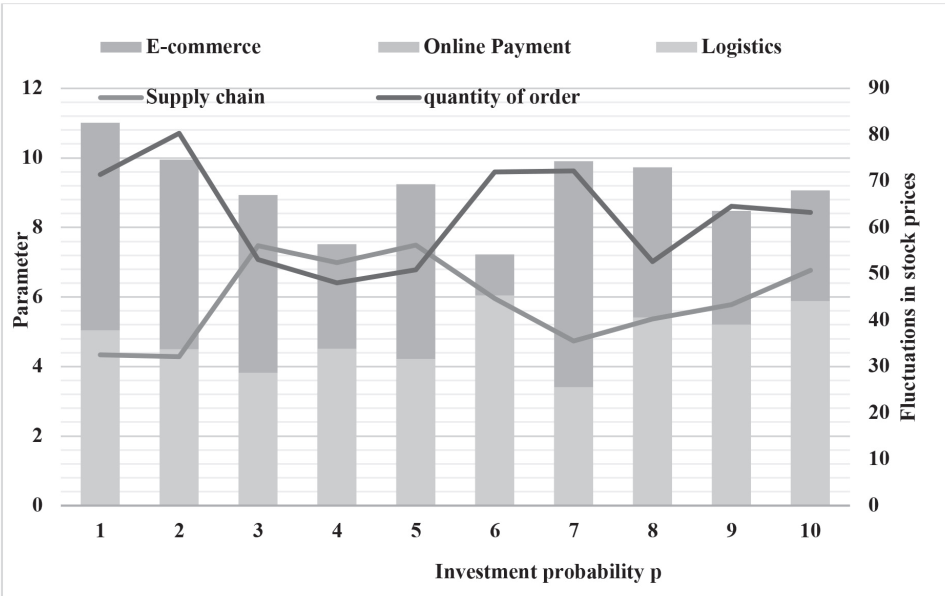

Figure 11 Impact analysis of investment group structure.

clusters There is constant competition and cooperation with clusters: because there is no artificial control of probability p below p1, the connection probability p may reach a critical value during the evolution process, and its trading behavior also affects the fluctuation of stock prices.

5. CONCLUSION

Regarding the interrelationship of each component, the entire system architecture can be divided into: platform support layer, data resource layer, data processing layer, internal business layer, and public service layer. The platform support layer solves all problems related to infrastructure, hardware resources, and software environment for financial big data public services. The data resource layer is mainly used for the management of the rights and responsibilities list and item catalog, and the data processing layer can transform information into understandable knowledge. The internal business layer is deployed based on cloud platforms and extranets, and is logically isolated from the Internet to ensure information security.

The operation technical support module of supply chain finance consists of four levels, namely, the collaborative supervision layer, the supply chain entity industry layer, the supply chain financial service layer, and the basic payment layer. These four hierarchical structures are both interrelated and independent. According to the basic data provided by the risk data loading layer, select the appropriate risk model in the risk model library, carry out data conversion and processing for the dimensions and topics of the risk model, and finally convert the complex redundant data of the native supply chain into a risk analysis Information. The “Inventory Financing Risk Analysis Dimension” model needs to assess the ownership of the goods, the supply and demand of the goods, and the industry risks of the goods. These data are provided by different participants in the supply chain and collected through their own source tables.

The core table of the database includes the information of each role in the supply chain, including the commercial bank table, the logistics enterprise table, the core enterprise table, and the small and medium-sized enterprise table. The enterprise credit information includes the enterprise reputation table, loan record table, and repayment record table. The financial service big data center requires various functional departments to open the data of relevant fields and industries through the data open platform in the form of data sets through the work deployment method, which is conducive to promoting the social development and utilization of big data. The industrial supply chain operation module standardizes the interface between logistics and supply chain management systems and related collaborative supervision systems.

COMPETING INTERESTS

This study was conducted with no conflict of interest. All authors have read the manuscript and approved its submission to your journal. We confirm that the content of the manuscript has not been published or submitted for publication elsewhere.

FUNDING

This work was supported by the Project of Guangdong University Engineering Technology Center (2022GCZX013), the Special Projects in Key Areas of Colleges and Universities in Guangdong Province (No. 2020ZDZX3046 and No. 2022ZDZX4062), and the Characteristics Innovation Project of Colleges and Universities of Guangdong Province (No. 2021WTSCX150), and the Research Center for Collaboration Innovation of Airport Economy (RCCIAE) of South China Business College of Guangdong University of Foreign Studies.

REFERENCES

1. AD. Mauro, M. Greco, M. Grimaldi, A formal definition of Big Data based on its essential features. Library Review 65(3) (2016),122–135.
2. L. Xu, C. Jiang, J. Wang, et al. Information Security in Big Data: Privacy and Data Mining. IEEE Access 2(2) (2017), 1149–1176.
3. Cai H, Xu B, Jiang L, et al, IoT-Based Big Data Storage Systems in Cloud Computing: Perspectives and Challenges. IEEE Internet of Things Journal 4(1) (2017), 75–87.
4. M. Chi, A. Plaza, JA. Benediktsson, et al, Big Data for Remote Sensing: Challenges and Opportunities. Proceedings of the IEEE 104(11) (2016), 2207–2219.
5. JY. Wang, MX. Xie, Geographical National Condition and Complex System. Acta Geodaetica et Cartographica Sinica 45(1) (2016), 1–8.
6. Z. Su, Q. Xu, Q. Qi, Big data in mobile social networks: a QoE-oriented framework. IEEE Network 30(1) (2016), 52–57.
7. A. Almalaq, J. Hao, JJ. Zhang, et al, Parallel building: a complex system approach for smart building energy management. Automatica Sinica, IEEE/CAA Journal of 6(6) (2019), 1452–1461.
8. D. Santos, P. Renato, On the Philosophy of Bitcoin/Blockchain Technology: Is it a Chaotic, Complex System? Metaphilosophy 48(5) (2017), 620–633.
9. A. Koenig, A. Fehn, J. Puck, et al, Primary or complex? Towards a theory of metaphorical strategy communication in MNCs. Journal of world business 52(2) (2017), 270–285.
10. W. Xu, H. Zhou, N. Cheng, et al, Internet of Vehicles in Big Data Era. IEEE/CAA Journal of Automatica Sinica 5(1) (2018), 19–35.
11. M. Bilal, LO. Oyedele, J. Qadir, et al, Big Data in the construction industry: A review of present status, opportunities, and future trends. Advanced Engineering Informatics 30(3) (2016), 500–521.
12. J. Hu, AV. Vasilakos, Energy Big Data Analytics and Security: Challenges and Opportunities. IEEE Transactions on Smart Grid 7(5) (2016), 2423–2436.
13. A. Barbu, Y. She, L. Ding, et al, Feature Selection with Annealing for Computer Vision and Big Data Learning. IEEE Transactions on Pattern Analysis & Machine Intelligence 39(2) (2017), 272–286.
14. Y. He, FR. Yu, N. Zhao, et al, Software-Defined Networks with Mobile Edge Computing and Caching for Smart Cities: A Big Data Deep Reinforcement Learning Approach. IEEE Communications Magazine 55(12) (2017), 31–37.
15. H. Liu, A. Gegov, M. Cocea, Rule based systems for big data: a machine learning approach 61(6) (2016), 799–803.
16. X. Ding, Y. Tian, Y. Yu. A Real-Time Big Data Gathering Algorithm Based on Indoor Wireless Sensor Networks for Risk Analysis of Industrial Operations. IEEE Transactions on Industrial Informatics 12(3) (2016), 1232–1242.
17. I. Yaqoob, IAT. Hashem, A. Gani, et al, Big Data: From Beginning to Future. International Journal of Information Management 36(6) (2016), 1231–1247.
18. IH. Chung, TN. Sainath, B. Ramabhadran, et al, Parallel Deep Neural Network Training for Big Data on Blue Gene/Q. IEEE Transactions on Parallel & Distributed Systems 28(6) (2017), 1703–1714.
19. BY. Chen, H. Yuan, Q. Li, et al, Spatiotemporal data model for network time geographic analysis in the era of big data. International Journal of Geographical Information Science 30(5–6) (2016), 1041–1071.
20. C. Stergiou, KE. Psannis, Recent advances delivered by Mobile Cloud Computing and Internet of Things for Big Data applications: a survey. International Journal of Network Management 27(3) (2017), 1–12.
21. H. Pan, "Application of 5G Wireless Communication and BIM Technology in Management of Construction Projects", Engineering Intelligent Systems, vol. 32 no. 3, pp. 191–201, 2024.
22. H. Shi, G. Cao, G. Ma, J. Duan, J. Bai, X. Meng, "Virtual Reorganization Algorithm Based on Cluster Intelligent Multi-task Production Line Manufacturing", vol. 30 no. 4, pp. 305–317, 2022.

Weihuang Dai received a master's degree in public administration from Sun Yat-sen University in 2016, and she obtained the qualification of Senior Human Resource Manager in 2017. She is an associate professor at the School of Management, and a researcher at the

Research Center for Collaboration Innovation of Airport Economy (RCCIAE) in South China Business College of Guangdong University of Foreign Studies. She has a strong scientific research ability and won excellent scientific research performance awards in 2018. Her current research interests include intelligent information processing, big data of human resources, public administration safety, and related areas.
E-mail: dwhgwng2008@163.com

Zijiang Zhu was promoted to Professor in 2019. He received a master's degree in software engineering from Wuhan University in 2009 and a senior engineer title in 2008. From 2012 to 2016, he was attended an MBA workshop held by Hunan University in 2012. He is currently Dean of the School of Information Science and Technology, deputy director of the Institute for Intelligent Information Processing, researcher at the Research Center for Collaboration Innovation of Airport Economy (RCCIAE) in South China Business College of Guangdong University of Foreign Studies, Guangzhou, China. His research areas include intelligent information processing, machine learning, big data technology, and related areas.
E-mail: zzjgwng2008@163.com

Deyu Qi, B.Sc., M. Tech., PhD. Tech., Professor, Doctoral Supervisor. He has been a professor at the School of Computer Science and Technology, a professor at the School of Software, a doctoral supervisor of Computer Science and Technology and Software Engineering students, and the director of the Institute of Computer Systems, all at South China University of Technology. He is also the director of the Joint Innovation Laboratory of Internet of Things of the University of Texas at Arlington and South China University of Technology, the chairman of the Guangdong Trusted Digital Identity and Cryptographic Blockchain Application Alliance, the chairman of Digital Science and Technology Branch of Guangdong Higher Education Association, the president of Guangzhou Future Information Technology Research Institute, the director of Ubiquitous Object Digitization Engineering Research Center of Guangdong Province, the Topic Editors of Frontiers in High Performance Computing of Fractal and Fractional. Meanwhile he is an adjunct professor at South China Agricultural University and Guangdong University of Technology, and a distinguished Professor at South China Business School of Guangdong University of Foreign Studies.
E-mail: qdygwng@163.com